Effects of Invasive Cape Ivy on the Mycorrhizal Presence in California Native Plants

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Abstract

Invasive plants change a biological community leading to a decrease of biodiversity amongst native plant species, however our understanding of the mechanisms underlying the adverse effects on native species is limited. Mycorrhizal fungi are an important component of terrestrial ecosystems that can affect the growth performance of native plants. The disruption of mutualisms between plants and mycorrhizal fungi is a potentially powerful mechanism by which invasive plants can negatively impact native plants. We investigated the effect of Cape ivy (*Delairea odorata:* Asteraceae), an invasive evergreen vine native to South Africa on the mycorrhizal associations of native plants in the coastal scrub plant community in northern California. We collected root and soil samples from areas invaded by Cape ivy and from non-invaded areas. Samples were examined microscopically for mycorrhizae. The presence of ectomycorrhizae and endomycorrhizae in soil and roots were compared. Results obtained show that fewer mycorrhizae were associated with dicot shrubs in the Cape ivy invaded area compared to that same plant species growing in non-invaded areas. Our results demonstrate that invasive species may reduce the competitive ability of some native plants by interfering with mycorrhizal associations. The results highlight the role of mycorrhizal symbionts and that soil microbiota should be considered in ecosystem management and restoration programs.

Aim

The purpose of this study is to further understand how Cape ivy invades and affects the rhizosphere of native plants.

Background

- Invasion by nonnative species can dramatically alter native plant communities. Soil microbes play key roles in ecosystems. However, few studies have investigated the effect of invasive plants on the rhizosphere.
- The coastal scrub community of California is characterized by perennial, evergreen shrubs (**Figure 1**). The coastal scrub of northern California is protected in the Golden Gate National Recreation Area (GGNRA).
- Cape ivy, *Delairea odorata,* (**Figure 2**) an invasive plant from South Africa, was introduced to the United States and is becoming the dominant species in some areas of the GGNRA, thus eliminating native biodiversity (1).
- Mycorrhizae are symbiotic fungi that grow in or on plant roots (5).
- Ectomycorrhizae form a mycelial mantle over the host plant's roots, which increases the plant's root surface area for nutrient absorption (6).
- Experiments performed on invasive *Centaurea stoebe* have shown that arbuscular mycorrhizal fungi (AMF) aid the plant both directly and indirectly thus allowing it to outcompete native species (2).
- Studies of native plant species in Senegal and Arizona (U.S.) show significant drops in the quantity of AMF when in the presence of invasive plants (3,4).
- We will investigate the effect of Cape ivy on mycorrhizae of native California coastal scrub plants

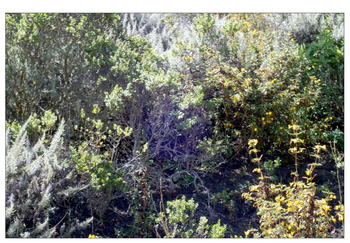

Figure 1. Normal diversity in the coastal scrub includes *Baccharis*, *Mimulus*, *Heteromeles*, and *Artemisia*.

Methods

Sample areas

Sample areas in Cape-ivy infested and non-infested areas were selected at random by throwing a 129-cm^2 grid near the plant desired.

Moisture percentage

1. Soil was collected near *Diplacus aurantiacus* and *Rubus ursinus* plants.
2. Collected soil was cleaned of rocks by sieving through a 3.44-mm sieve and weighed.
3. The soil was dried at 120°C for 20 min and reweighed. This process was repeated until the soil reached a constant mass.
4. Soil moisture was calculated using the initial weight of the soil and the weight of the anhydrous soil.

Mycorrhizal Spores

1. Soil slurries of each sample were prepared using 200 g soil and 500 mL water.
2. Slurries were then passed through a series of sieves (3.44 mm, 1.65 mm, 0.86 mm, 0.38 mm.)
3. Soil remaining after the 0.38-mm sieve was collected and examined microscopically for the presence of mycorrhizal spores.

Arbuscular Mycorrhizae Preparation

1. *D. aurantiacus* and *R. ursinus* root samples were obtained in multiple Cape-ivy infested and non-infested areas. Collection was randomized by throwing the 129-cm^2 grid in an area. Flashcards were numbered one to 25 to correspond with a particular square on the grid. One flashcard was chosen at random. The grid that resulted was the area from which roots were obtained.
2. Roots from each sample were separated-and stained according to Coyne (8) and Sylvia (9)
   a. Roots were immersed in 40 mL 10% KOH, and autoclaved for 10 min at 15 psi to remove cytoplasmic contents from cells.
   b. The roots were bleached in 40 mL alkaline H_2O_2 at room temperature.
   c. Roots were acidified in 40 mL HCl for 3 min.
   d. The acidified roots were then stained by autoclaving at 15 psi for 10 min in 40 mL of a solution of acid fuchsin in lactic acid-glycerin.
   e. Roots were destained in 45 mL lactic acid-glycerin for 2 days, which left only arbuscular mycorrhizae stained.
   f. Roots were examined microscopically for arbuscular mycorrhizae.

Figure 2. In invaded areas, Cape ivy blankets the ground and inhibits new growth of almost all other vegetation.

Results

- Soil moisture was comparable in infested (10.9%) and non-infested areas (11.9%).
- The most commonly seen spores were *Glomus* spp. (**Figure 3**).
- Cape ivy had a negative impact on the presence of arbuscular mycorrhizae of *D. aurianticus,* but had no comparable impact on *R. ursinus* (**Figure 4**).
- There was a significant decrease in soil mycorrhizal spores in Cape-ivy infested areas near both *D. aurianticus* and *R. ursinus* (**Figure 5**).

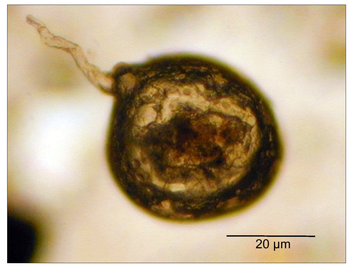

Figure 3. *Glomus ambisporum* spore found in the soil of *D. aurantiacus*.

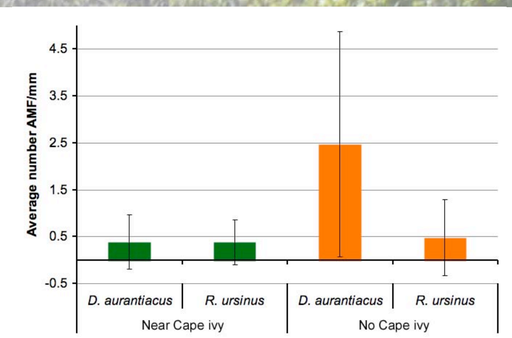

Figure 4. Arbuscular mycorrhizal fungi (AMF) per 1 mm of root; spores resembled *Acaulospora foveata*. Error bars = 1 S.D.

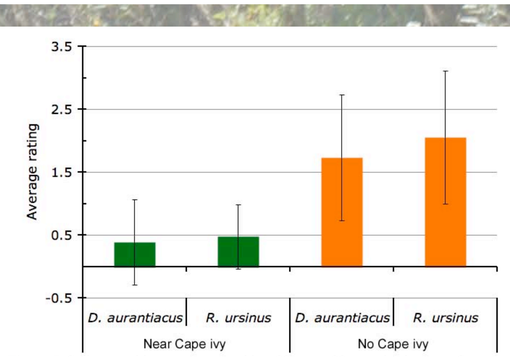

Figure 5. Soil mycorrhizae were counted in a 22 mm × 22 mm viewing area. Spore presence was rated on a scale of of 0 (none) through 4 (greatest). Spores closely resembled to *Glomus ambisporum.* Error bars = 1 S.D.

Discussion & Conclusion

- Water availability was not a factor because soil moisture was similar in the study areas.
- Exposure to wind direction and other plant species were similar in the infested and non-infested areas, narrowing the cause to Cape ivy.
- *R. ursinus* is capable to compete in the presence or absence of Cape ivy.
- More samples of other brush are needed to further solidify the negative affects of Cape ivy to the coastal scrub community.
- The presence of Cape ivy may be affecting the rhizosphere of native plants, inhibiting the native plant from attracting the mycorrhizal fungi.
- These results underscore the threat of invasive species to ecological services.
- These results and future results may lead to further understand the success of invasive Cape ivy and the solution to ridding the coastal scrub community of Cape ivy.

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